Research and Design of Unmanned Restaurant Systems

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Abstract: With the development of the economy, traditional catering enterprises generally have problems of high operating costs, large labor demand, backward productivity, and low efficiency. The reform of catering enterprises is imminent, and a new type of unmanned restaurant system research has emerged. The system uses the WeChat applet to build a user platform, builds a server for data transfer, and the backend web interface displays order information. The robot uses the OpenCV vision library to identify the coordinate information contained in the QR code, collects the surrounding environment information through the laser radar, constructs the map through the laser slam algorithm, and the A* algorithm realizes the independent planning path and autonomously delivers the target position for the user to take the meal. After completion, the self-planning path returns to the origin standby and the meal information is transmitted back to the server.

1. Introduction

As a labor-intensive industry, traditional catering enterprises have been plagued by problems such as difficulty in recruiting workers, difficulty in retaining people, and high labor costs. The operating principle of “intelligent, simple, and standardized” and the business idea of “machine substitution” have a longer-term advantage. Affected by the per capita disposable income and the rapid iteration of advanced technologies such as the Internet of Things, big data, computers, human-computer interaction, etc. the service robot industry has greater opportunities and space, or will become the main force of the future robot manufacturing industry, market share cannot be estimated. Based on this situation, the application of robots to catering enterprises can avoid the drawbacks of traditional catering enterprises and has obvious advantages [1, 2]. Such as saving labor, high work efficiency, low operating costs, long-term use, etc. Based on this background, we have studied the unmanned restaurant system, which solves the problem that users can choose their own online meals and robots to deliver meals.

2. System overall framework

For the sake of data security and better performance, the overall structure of the system is roughly divided into three parts: User platform, Connection platform, Robot platform. User platform development includes the development of WeChat applets, server building and background web interface development and data transfer between them; The robot platform includes robot construction, circuit design, ROS operating system application, slam algorithm implementation, motion solution calculation and motion data transfer between each other; The connection platform includes the generation of the QR code information and the recognition of the QR code information by the OpenCV to obtain the coordinate data and the order information of the user. The user logs in to the WeChat applet to check the remaining information and menu in advance. After the order is placed, the information is sent to the background webpage through the server. The staff can view the information preparation dishes. After the preparation is completed, click Finish to generate the QR code. After the robot scans the QR code, Get user seat information. Then the robot independently

plans the path to send the dishes to the target location. After the user completes the meal, the robot returns to the original place to wait for the next task. The system work flow chart is as shown:

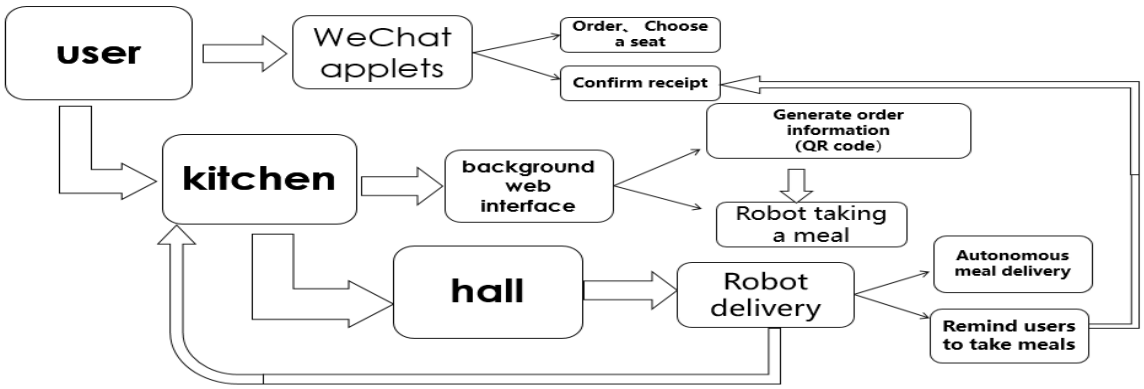

Fig. 1 System work flow chart

3. System structure development

3.1 Mechanical structure.

The application of the triangular structure to the mobile robot has a better advantage. We adopt the triangular structure as the overall mechanical structure. In addition, the use of omnidirectional wheels makes the movement of robots more convenient and flexible [3]. A bottom plate is added to the chassis for mounting the circuit board and the battery, and above the chassis is a tableware storage structure, and a laser radar and a camera are placed on the top of the tableware storage structure to sense the external environment.

The chassis of the robot is built with 4MM double-layer aluminum plates. The appearance is simple and beautiful, and it is durable and not easily damaged. as the Figure shows:

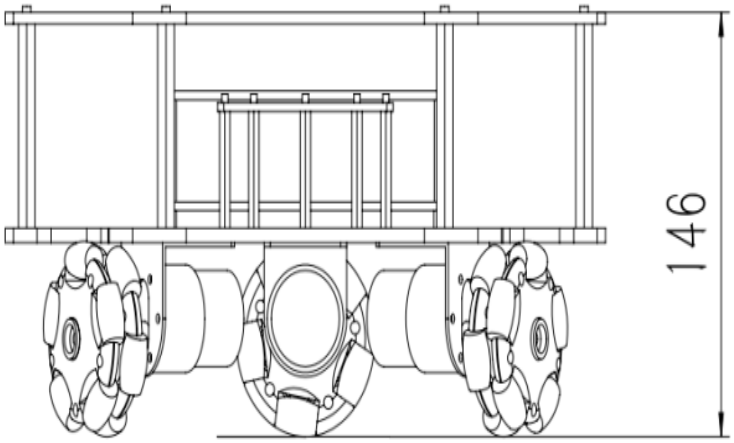

Fig. 2 Chassis structure

The robot storage structure adopts a box for placing the tableware on the bracket. When the robot reaches the target position according to the self-planned path, the stepping motor is started, and the bracket of the box is pushed up to a specified height. With this structure, the robot has a lower center of gravity and a higher safety factor when moving. The storage structure is as shown:

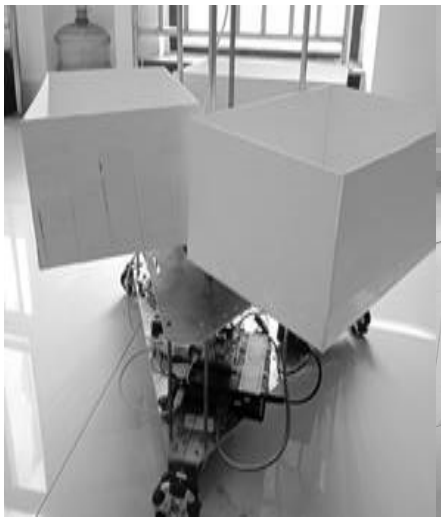

Fig. 3 Storage structure

Fig. 4 Bracket structure

3.2 Hardware structure.

The robot uses the Raspberry Pi as the host computer and the STM32 microcontroller as the lower computer.They communicate through the serial port. The main control STM32 is connected to the motor drive module and a sensor such as an encoder to correct the position of the robot itself. A camera is installed on the Raspberry Pi to identify the QR code to obtain the coordinates of the user's seat. Install the lidar on the Raspberry Pi and run the lidar to collect the surrounding environment information by running the navigation package on the Raspberry Pi. The PC observes the data through the LAN on the Raspberry Pi. The specific connection Figure is as shown:

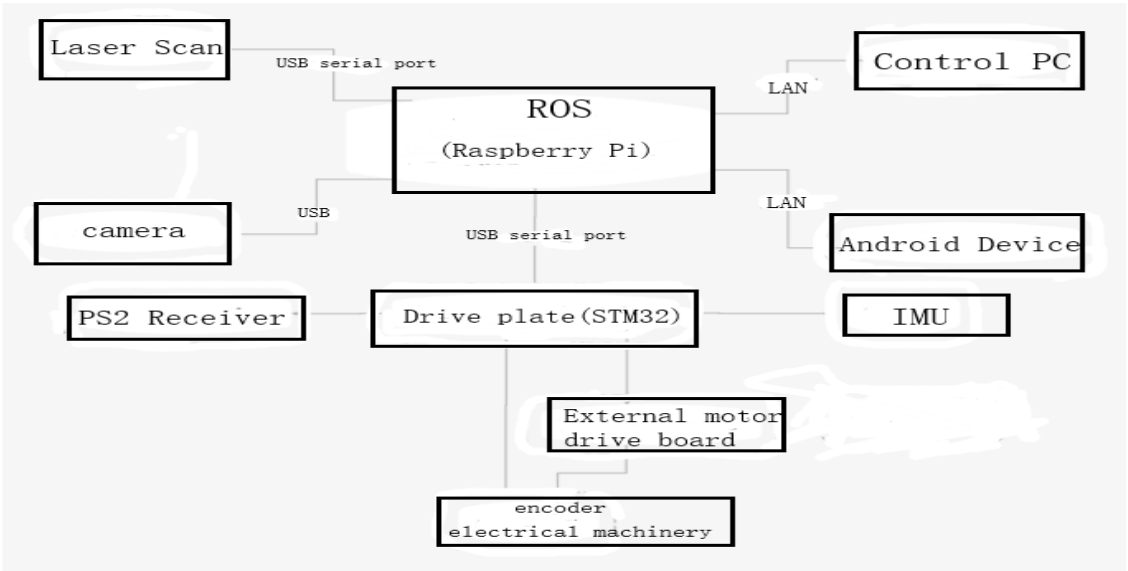

Fig. 5 Hardware connection structure

4. Software framework development

4.1 User platform.

Choosing to use the WeChat applet as a user platform, compared to the APP, the applet can promote and has a lower cost. Moreover, there are many interfaces in WeChat that can be easily transferred to the server and database for data construction, so that a user framework can be completely constructed [4].

Users can check the operation status of a restaurant at any time. Check whether the restaurant has seats before going to the restaurant. If there is a seat, users can order and choose seats online. After

the order is placed, the data will be transmitted to the server to view the order data, and the Web interface displays the order information, and the chefs are prepared to prepare meals in the kitchen.

4.2 Connection platform.

The connection platform uses a QR code with a high degree of application and a high data transmission safety factor for data transmission [5]. The QR code contains the coordinate information of each table number of the restaurant.

After the kitchen preparation is completed, click on the web interface to generate a QR code map, and display the QR code image through a small screen to the 20cm position before the robot stands by. When the QR code appears on the screen, the camera on the robot can accurately identify the information on the QR code. After obtaining the QR code information, it starts his meal delivery task.

4.3 Robot platform Connection platform.

The robot platform is developed under the ROS robot operating system. The laser slam algorithm is first used to construct the entire map, and the location information of the entire restaurant was saved on a map. After the whole map is built, the initial position of the robot is set and then the global navigation and partial path planning are adopted to realize the autonomous navigation and autonomous obstacle avoidance of the robot [5, 6, 7]. So that completing the meal delivery in the restaurant, after the user takes the meal, the robot will re-plan the path back to the initial point standby.

5. Summary

The unmanned restaurant is based on the operating principle of “intelligence, simplification, and standardization” and the business idea of “substitution for people”. There are two advantages that traditional enterprises cannot match. First, the use of the network and new smart devices to make customers order more convenient and save the number of labor and labor costs. Secondly, attracting customers to experience, increasing passenger flow and popularity, while customers ordering food and receiving food in any time, can greatly shorten the time of ordering and improve efficiency.

On the one hand, it saves operating costs: smart terminal equipment is a one-time investment that can be used for a long time. On the other hand, it saves the back-office area and increases the operating area. Work as much as possible in the central kitchen, and 80% of the restaurant is reserved for customers. This kind of space allocation is not only conducive to ensuring the consistency of the quality of the products, but also in today's high rents, the increased operating area also means increased income. Whether at home or abroad, unmanned restaurant will set off a new wave.

The research of unmanned restaurant system project meets the needs of the development of smart society. The design and development of the system realizes the perfect combination of hardware and software, not only focusing on the practicality of the system, but also considering the security of the system. The test has achieved good results in the experimental environment. Among them, the feeding robot is a highlight in the system, further improving, strengthening the communication between the robots, and realizing the coordination work of the robot in the whole meal feeding process, which will have a wide application value.

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